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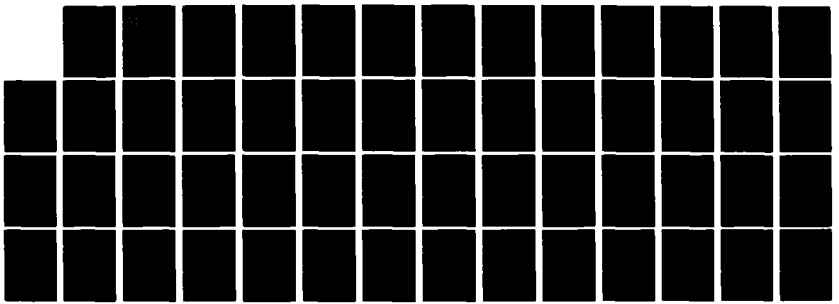

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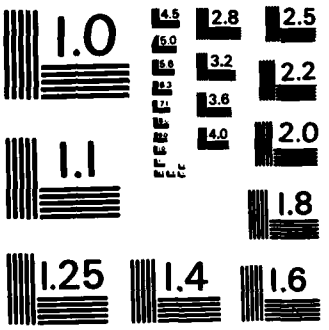

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REPORT TDI-TR-82-5

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VIDEODISC TRAINING DELIVERY SYSTEM PROJECT

FINAL TECHNICAL REPORT

By

Andrew S. Gibbons, Ph.D.

1 JULY 1982

Approved for Public Release:
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PREPARED FOR: *US Army Training and Doctrine Command*
Fort Monroe, Virginia 23651

NOTICES

This report has been reviewed and is approved.

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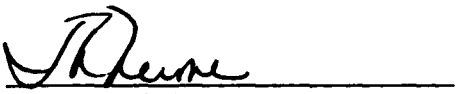
Chief, Instructional
Development Division



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The rapid development and proliferation of complex technology in all areas of the military has resulted in an increase in paper-based technical documentation that is fast becoming unmanageable. The recognition of this growing problem prompted the establishment of the Army Communicative Technology Office, with one of its missions to explore emerging technology and its application to the documentation delivery requirements of the modern army. The application of technology applied to documentation has a direct effect on training. This project was one of the first joint efforts to explore and use videodisc (cont'd)

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Item 20 (cont'd) technology in the US Army training community. The purpose of the project was to prepare a series of seven lessons to be administered by consumer-model videodisc player. This report describes the videodisc courseware development and includes a summary of encountered problems, solutions thereto, and lessons learned.

VIDEODISC TRAINING DELIVERY SYSTEM PROJECT

FINAL TECHNICAL REPORT

Andrew S. Gibbons, Ph.D.

The US Army Training Developments Institute
Fort Monroe, Virginia 23651

August 31, 1981

DISCLAIMER

The contents of this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

EXECUTIVE SUMMARY

The rapid development and proliferation of complex technology in all areas of the military from weaponry to telecommunications has resulted in an increase in paper-based technical documentation that is fast becoming unmanageable. This problem was recognized several years ago by the commanders of the US Army Training and Doctrine Command (TRADOC) and the US Army Communications Electronics Command (CECOM). The recognition of this growing problem prompted the establishment of the joint TRADOC-CECOM Army Communicative Technology Office (ACTO), with one of its missions to explore emerging technology and its application to the documentation delivery requirements of the modern army. The application of technology applied to documentation has a direct effect on training. TRADOC, recognizing this, has tasked its Training Developments Institute (TDI) to support ACTO in the exploration of technology applied to training and training delivery. This project, Videodisc Training Delivery System (VTDS), was one of the first joint efforts to explore and use videodisc technology in the US Army training community. The VTDS project is part of the ACTO Electronics Information Delivery System (EIDS) and Military Electronics Information Delivery System (MEIDS) programs. TDI is responsible for the evaluation of the training application of the videodisc for resident training delivery.

The purpose of this project was to prepare a series of seven lessons to be administered by consumer-model videodisc player. The seven lessons were close translations of a set of lessons taken from the Tactical Communications Systems Operator/Mechanic (31V10) module entitled "Troubleshooting Medium Powered Frequency Modulated (FM) Radios, AN/VRC-12 Series" and were prepared on videodisc for the specific purpose of providing an operational test. The operational test, scheduled to follow the project, is intended to "evaluate the technical effectiveness of ... the videodisc" and lessons were to be developed "capitalizing on all the inherent characteristic features of a videodisc player."

The purpose of this report is to describe the videodisc courseware development and effort. It includes a recapitulation of the background and motives for the project, a brief historical account, a description of the processes used during the project and the rationale behind them, a summary of problems encountered during the project, the solutions to them and the lessons learned from these problems which may be used to benefit future projects of this type for both in-house and contractor training development organizations.

Following a brief introduction, the report is divided into three sections. Section 2.0, "Project Description", summarizes the work effort and general procedures of the project and contains a statement of the rationale used during development. Section 3.0, "Problems, Solutions, and Lessons Learned", focuses on the development lessons pointed up during the project. Section 4.0, "Recommendations", builds on Section 3.0 and proposes practices and policies aimed at avoiding problems on similar projects where possible in the future.

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DELIVERY SYSTEM PROJECT
FINAL TECHNICAL REPORT

1.0 Introduction

The purpose of this project was to prepare a series of seven lessons to be administered by a consumer-model videodisc player. The seven lessons were close translations of a set of lessons taken from the Tactical Communications Systems Operator/Mechanic (MOS 31V10) module, entitled "Powered Frequency Modulated (FM) Radios, AN/VRC-12 Series" and were prepared on videodisc for the specific purpose of providing an operational test. The operational test, scheduled to follow the project, is intended "to evaluate the technical effectiveness of ... the videodisc" and lessons were to be developed "capitalizing on all the inherent characteristic features of a videodisc player."

The purpose of this report is to describe the videodisc courseware development effort. It includes (1) a recapitulation of the background and motives for the project, (2) a brief historical account, (3) a description of the processes used during the project and the rationale behind them, (4) a summary of problems which may be used to benefit future projects of this type for both in-house and contractor training development organizations. The contractor for this effort, WICAT Systems, adheres to and promotes sound instructional systems development (ISD) practices. Due to the specific nature of this project as an evaluation of a medium, restrictions were placed on the scope of development processes. Within those limits, good development practices were applied, and problems encountered are mentioned in this report in hopes of benefiting future development efforts.

The balance of this report is divided into three sections. Section 2.0, "Project Description," summarizes the work and general procedures of the project and contains a statement of the rationale used during development. Section 3.0, "Problems, Solutions, and Lessons Learned," focuses on the development lessons dramatized during the project. Section 4.0, "Recommendations," builds on Section 3.0 and proposes practices and policies aimed at avoiding those problems where possible in the future.

2.0 Project Description

2.1 Background. The rapid development and proliferation of complex technology in all areas of the military from weaponry to telecommunications has resulted in an increase in paper-based technical documentation that is fast becoming unmanageable. This problem was recognized several years ago by the commanders of the US Army Training and Doctrine Command (TRADOC) and the US Army Communications Electronics Command (CECOM). The recognition of this growing problem prompted the establishment of the joint TRADOC-CECOM Army Communicative Technology Office (ACTO), with one of its missions to explore emerging technology and its application to the documentation delivery requirements of the modern army. The application of technology applied to documentation has a direct effect on training. TRADOC, recognizing this, has tasked its Training Developments Institute (TDI) to support ACTO in the exploration of technology applied to training and training

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2.2 Chronology and Tasks. Work was initiated on the contract in September 1980. The original contract effort was planned to continue for 26 weeks, with work scheduled for completion the first part of March 1981. Subsequently, as described in this report, the contract completion date was extended to September 1981.

The contractor effort was divided by the original Statement of Work (SOW) into four tasks. Each task was in turn subdivided into individual events. Each event specified work to be completed by the government or by the contractor. Tasks and events are listed in Table 1 (page 3). The tasks included activities normally considered part of the ISD process described in TRADOC Pamphlet 350-30, with the exception that not all steps of the ISD process were required by the tasks and events. Tables 2 and 3 (pages 4 and 5) show the correspondence between SOW tasks and the ISD process activities as described in Pamphlet 350-30. An inspection of those tables show that the normal ISD process was entered as if analysis and media selection decisions had already been made. Contractor tasks provided for the review of existing materials followed by the design and writing of the seven lessons. Production of lesson materials followed lesson authoring. It was decided by the government participants that a review of the authored lessons by a "board of experts" would be used in lieu of formal validation trials. The rationale for this determination was the excessive cost and increased time required to procure trial discs and revise them based on data obtained. The time and cost for disc production is a key factor in using videodisc for training.

Data included in the SOW provided estimates of the instructional time covered by the original instruction which was to be replaced by the seven videodisc lessons. These figures are included in Table 4 (page 7).

Once produced in final production-ready form, storyboard scripts for each lesson and final art were submitted to the US Army Field Artillery School (USAFAS) at Ft Sill, OK. The Training and Audio-Visual Support Center television studio produced the master videotapes from the final scripts for videodisc production.

The storyboard format supplied with the SOW specified how art and narration data were to be prepared on storyboard forms. During the course of the contract, the contractor recommended a modified storyboard form having the following beneficial characteristics:

1) one-per-page placement of audio and visual material, facilitating insertion and deletion of individual videodisc frames and sequences, and

2) expanded area for organizing data related to technical production of the master videotape.

It is felt that this revised storyboard improved the amount of information which could be conveyed to the production group. A sample storyboard page is presented in Figure 1 (page 8). More detailed descriptions of the forms used follow later in the report.

TABLE 1

Tasks and Events Included in
Statement of Work

Task I - Review Course Material and Develop Contract Performance Plan (CPP)

Event 1: Government provide government furnished material (GFM)
Event 2: Contractor review GFM and develop CPP
Event 3: Government approve CPP

Task II - Develop Lesson Scripts and Perform Videotape Productions

Event 4: Develop draft videodisc scripts and adjunct material
Event 5: Government review and approve
Event 6: Develop final material and art work
Event 7: Government review and approve
Event 8: Government produce videotape
Event 9: Contractor advisement for production

Task III - Develop Knowledge-Retention Test

Event 10: Develop retention test
Event 11: Government review and approve

Task IV - Documented Report on Development of Videodisc Production Script for Interactive Videodisc Lesson

Event 12: Develop courseware development documentation
Event 13: Government review and approve

TABLE 2

Comparison of TRADOC Pamphlet 350-30
(Interservice Procedures, Phase II)
and Project Development
Procedures

Phase II DESIGN

TRADOC Pamphlet 350-30 Approach	Project Approach
II.1 Develop Objectives	Perform (Insure the complete range of necessary objectives has been identified and that objectives are stated in job-like terms as far as possible.)
II.2 Develop Tests	Perform (Specifications for retention tests are clearly spelled out in Statement of Work.)
II.3 Describe Entry Behavior	Perform (General student characteristics are described by MOS qualifications. Specific knowledge of the subject by students is assumed from prior portions of the course.)
II.4 Determining Sequence and Structure	Perform (To create lesson maps.)

TABLE 3

Comparison of TRADOC Pamphlet 350-30
(Interservice Procedures, Phase III)
and Project Development
Procedures

Phase III DEVELOP

TRADOC Pamphlet 350-30 Approach	Project Approach
III.1 Specify Learning Events/Activities	Perform (Select appropriate instructional strategy for each objective best suited to capabilities of videodisc medium.)
III.2 Specify Management Plan and Delivery System	Perform in part (Media already selected. Management decisions made within overall SOW provisions.)
III.3 Review Select Existing Material	Perform (Limit to existing course materials while remaining alert to other possibilities.)
III.4 Develop Instruction	Perform (Product was scripts and adjunct materials.)
III.5 Validate Instruction	Perform in part (Review by board of experts.)

Task 3 called for the development of a memory retention test. Guidelines provided by the SOW for the development of the test were intended to insure that the test would sample items from lesson quizzes in direct proportion to the importance and size of each of the lessons. The expectation was that this retention test would consist of items common to both old and new instructions so a comparison could be made. To provide that assurance, questions were eliminated from selection for the retention test which were not common to both old and new instructions.

2.3 Participating Organizations. The project was the cooperative effort of a group of five organizations, whose roles are shown below:

Organization	Role
Electronics Division Communications Electronics Department (CED) US Army Field Artillery Center and School (USAFAC) Ft Sill, OK	- Supplied course materials - Provided technical content guidance - Performed script technical reviews - Implemented product
TV Branch (TVB) Training and Audiovisual Support Center (TASC) USAFAC Ft Sill, OK	- Produced videotape masters
Training Developments Institute (TDI) Ft Monroe, VA	- Funded project - Provided contract monitoring - Reviewed all products
Army Communicative Technology Office (ACTO) Ft Eustis, VA	- Reviewed all products - Provided videodisc technical guidance
WICAT Systems 1875 South State St. Orem, UT	- Wrote storyboard scripts - Created production art - Assembled production lists - Compiled knowledge-retention tests - Documented project

The Electronics Division, CED, USAFAC, provided subject-matter expert (SME) review and technical approval of the storyboard scripts. In addition, that organization evaluated each script for suitability and integration into the course on FM troubleshooting.

Representatives of both TDI and ACTO reviewed all storyboard scripts and provided detailed comments. Coordination of all work efforts originated from TDI, which had the main management responsibility for the project.

TVB was responsible for producing the master videotape for videodisc mastering. Officially this organization was not involved in the review cycle. It was recognized from the beginning of the project, however, that the production studio needed to know script content as early as possible and needed to participate in the development of scripts. Consequently, TVB was included in the review of scripts as a matter of standard practice.

TABLE 4

Summary of Existing
31V10 Instruction

Lessons	Total Minutes of Lesson Time Including Hands-On Training	Original number of Slides	Original Audiotape Time (Min)
(1) Application of identification of AN/VRC-12 Series Radios; FM Radio Principles	115 *	77	28.0
(2) Installation of AN/VRC-12 Series Radios	130	65	22.75
(3) Radiotelephone Procedure	110	57	19.75
(4) Evaluate Operation of AN/VRC-12 Series Radio	225	76	23.0
(5) Troubleshoot AN/VRC-12 Series Radio Sets for a Defective Circuit	200	51	15.5
(6) Troubleshoot AN/VRC-12 Series Radio Set's Power Input Circuit	265	73	28.5
(7) Troubleshoot Antenna Matching Unit Control Circuit	180	66	27.25
TOTAL	1225	465	164.75

*2 lessons
85 minutes on first lesson
30 minutes on second lesson

Production Sheet No. _____

Lesson_____ Segment_____ SMPTE( ) __ __ __ to __ __ __
Compositor Cartridge-Page _____ Estimated time (second)_____
Branch on_____ To_____

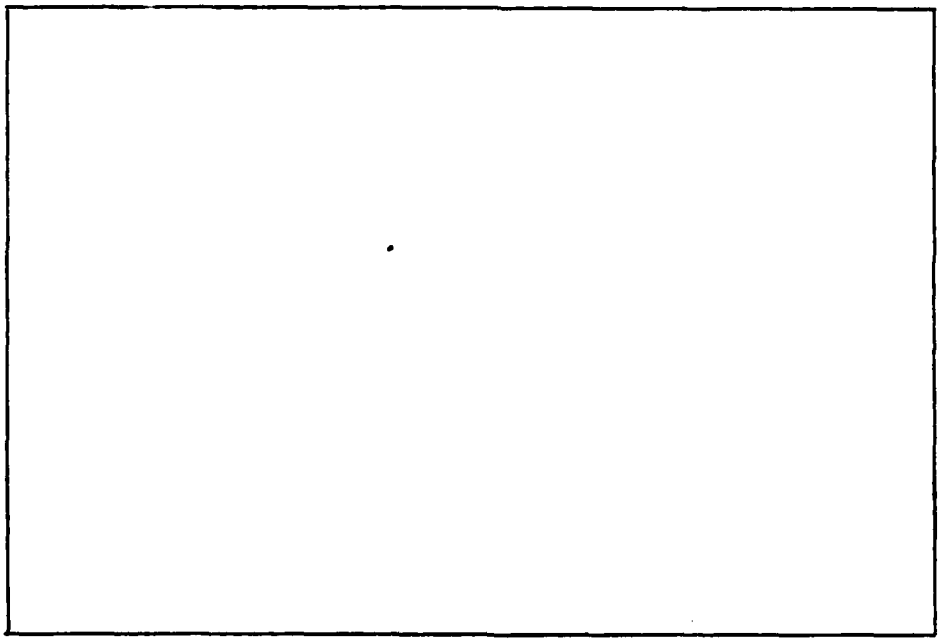
GRAPHICS: __Prop __Art __Photo No._____ NOTES_____

VIDEO: __Still __Motion Tape( )__ __ __ to __ __ __ NOTES_____

COMPOSITOR: __External __Text __Animation NOTES_____

STUDIO: __Split __Quad __Window __Highlight NOTES_____

PROGRAMMING: __Stop Calc Frame No._____ Actual_____



AUDIO: _____

_____

_____

_____

Figure 1.

Sample Storyboard Form

2.4 Contractor Staffing. The contractor staff for this project consisted of one Instructional Psychologist/Project Director, one Instructional Technologist/Script Writer, and one SME in MOS 31V10. Art and production talent was hired on an "as needed" basis for the project, and secretarial and editorial assistance was drawn as required from the pool of company resources.

2.5 Actual Procedures. The development tasks executed during the project correspond to the task and event sequence prescribed in the SOW. Following a review of the existing lesson material, the team Instructional Psychologist specified instructional objectives and the instructional strategy to be used for each. From that point the Instructional Psychologist and the Instructional Technologist jointly authored the lessons according to the specification.

For each lesson an adjunct guidance package was developed in addition to lesson storyboard scripts. This booklet-form material was prepared to direct the student through each of the phases of the lesson. In addition, the guidance package provided a complete summary of the quiz items from the lesson the student could use as a carry-away reference source.

For Lesson 4, in addition to the storyboard script and guidance package, a job performance aid (JPA) was also developed using the materials supplied with the original lesson material. This required an additional week's effort, but was necessary since the lesson took its content from the JPA.

Following the preparation of the initial script, the contractor SME reviewed the script for technical accuracy. In most cases the SME was able to deal competently with technical content, which was general to the MOS 31V10. Some difficulty was encountered in dealing with content which was unique to the CED training. Over the period of the project CED and the contractor agreed upon standards in terminology. This simplified dealing with these peculiarities of the content. The CED SMEs were able to review the scripts in those areas in which the contractor SME was not knowledgeable.

Following the government SME technical review, scripts were given a final contractor review, edited, and delivered for review to TDI, ACTO, and USAFAC CED (which shared its script with TVB). The reviews provided by these organizations were detailed and covered the gamut from technical content corrections to production technique recommendations. Since both the TDI and ACTO reviews could be considered relatively naive to the technical content of the lessons, they provided a logic and consistency check and insured that noncommunicating language and visuals were revised.

Comments from the draft script review were returned to the contractor, and revisions made. Most recommendations were accepted, while others were negotiated. The scripts benefited from this exchange between the contractor and government activities.

Following revision, the storyboard script and camera-ready art were prepared in final form for delivery. The camera-ready art was prepared through a photopositive process on acetate with colored backs. These art cells were back-painted in the style of animation productions to achieve a professional finish. In addition to the delivery of final storyboard script and camera-ready art, a narration script and set of production lists were delivered as well. These were not required as deliverable items, but each was a logical necessity to the production process. The narration script was required for use by the narrator recording the audio message. The production lists listed

individual art pieces, still and motion video shots, and required props. A sample of the narration script and production lists are presented in Attachment 1.

Submission of the final storyboard script and camera-ready art were listed as the final step in script production. It was necessary, however, to conduct revisions based on the review of these final products. This involved in every case preparation of a third version of the storyboard script and revisions to camera-ready art pieces. This step was an unexpected but unavoidable necessity in preparing materials for production.

In the case of Lessons 2 through 5, a second round of revisions was also made of draft storyboard scripts. This was necessary to incorporate the standard lesson structure more fully into these lessons and to allow for changes in content of the lessons due to revision of the JPA and Army technical doctrine.

Knowledge-retention test production took place according to the procedures specified in the original SOW, as described below. All quiz items appearing in both the old and the new instructional materials were placed in a pool. Items were sampled from this pool, with a set number being taken for each lesson, as specified in the SOW. Alternate test forms were created by scrambling item order.

The contractor provided on-site consulting during the studio production of the first videotape at Ft Sill. For the first three scripts, it was desirable to coordinate the intent of the script writers with TVB production personnel through preproduction conferences. In these preproduction conferences, the storyboard scripts were reviewed page by page by contractor and production personnel. Following the first three, these conferences were discontinued. Though these conferences were not required by contract, they were extremely helpful to the production personnel and should be considered necessary in future products of this type.

2.6 Instructional Rationale - Theoretic Point of View. The instructional rationale used during the production of the storyboard scripts was the product of many factors. This section of the report covers the factors that influenced choice of instructional strategy. In the next section the implementation of the instructional strategy plan is described as it impacted use of the control features of the videodisc player.

The term "instructional strategy" suggests just one level of decisions being made, when in fact strategy decisions are made at several levels during instructional development.

2.6.1 Between-Lesson Strategy. Strategy decisions must be made concerning between-lesson instructional sequence. For the present project, a plan was submitted with the proposal for a between-lesson sequence. However, the necessity of maintaining integrity between existing and new lessons in the course prevented its implementation.

2.6.2 Within-Lesson Strategy. Strategy decisions must be made which dictate the order of instruction within the lesson. The term "lesson" itself is misleading. Some instructional developers define a lesson in terms of the number of instructional objectives taught. Others define a lesson in terms of the amount of instructional time consumed. For the purposes of this project, the

term "lesson" referred to a grouping of from six to twelve instructional objectives. In most cases, due to the nature of the objectives contained in the lessons, and due to their heavy reliance on memory and knowledge-related behaviors, the sequence was not a "skill-building" sequence as much as a sequence dominated by terminology. It was important during the ordering of objectives within each lesson to insure that terminology was not used during instruction prior to its being defined for the student.

A second strategy question encountered at the within-lesson level was the extent to which the structure of the lesson would be apparent to the new student. It was decided because of the nature of the new and unfamiliar medium, that the structure of the lesson should be highly visible to the student, providing a series of "roadsigns" which the student could use to maintain orientation in what might otherwise be a maze of facts and procedures. Roadsigns were intended to be easily recognizable points which would allow the student to determine easily his location in a lesson.

Several elements in the lessons had "roadsign" properties. For instance, the beginning of each objective was marked by a 30-frame (one second playing time) sequence in which only the word "objective," and a numeral appeared. A student scanning forward or backward would find such an image an easily recognizable roadsign on the videodisc. Directly following this roadsign was an element stating the objective. The pattern of frames at the beginning and at the end of the instruction for one objective was always the same. The objective numeral and objective image always appeared at the first of such a sequence and a patterned quiz over the materials always came at the end.

In addition to the regularities at the beginning and end of an objective sequence, regularities during the sequence were attempted through the labeling of each instructional frame with the title describing the information in the frame. A regular set of frame titles was used corresponding to information types given during the lesson. Frames containing material which provided context for or motivated the student toward the main idea were labeled "Introduction." Frames containing the main message related to the instructional objective were labeled "Main Idea." Elements intended to recap material already covered in the lesson were labeled "Review." Elements intended to elaborate on the main idea, by giving emphasis or additional explanations, were labeled "Discussion."

This practice of labeling information types is related to a body of research which has demonstrated that the labeling of instructional information does allow students to make more efficient use of information and does affect learning of the information. However, at the between-objectives level of instructional strategy decisions, this device also served as a type of roadsign, which the student could use to remain oriented during an instructional presentation.

2.6.3 Objective-Level Strategy. Another level of instructional strategy decisions was at the level of the individual instructional objective. One strategy question at this level concerned the match between the behavior contained in the instructional objective and the behavior taught to and practiced by the student during instruction. It is not uncommon to find a mismatch between the objective behavior and the behavior taught during the instruction, and the behavior practiced by the student. This is a common source of confusion and poor performance in training programs. In its original proposal documentation, WICAT proposed that instructional objectives would be categorized into four or five categories and that for each category specific guidelines could be formulated to guide instructional and strategy choice. This choice

would include both exposition and inquisition (practice) guidelines. One purpose of these guidelines is to insure a match between the behavior in the objective, the behavior taught, and the behavior practiced by the student.

A second purpose for these guidelines is to insure that the instructional approach used for a given objective is the most efficient and effective one possible. Dramatic improvements in acquisition efficiency and retention have been achieved in many cases through the use of appropriate instructional strategies in the past in both laboratory studies and actual field training applications.

Where possible throughout the project, the capabilities of the consumer-model videodisc player were used to implement instructional strategies specially suited to the category of the instructional objective. Thus a drill-and-practice routine was included during the instruction of the phonetic alphabet in Lesson 3. The phonetic alphabet is essentially a symbol-to-symbol association learning task for which drill-and-practice is well-suited. On the other hand, during instruction on discriminating between adequate and inadequate radio calls, multiple examples are used of both proper and improper radio calls to assist the student in forming an appropriate discrimination ability.

2.6.4 Message Property Strategy. A final level of strategy consideration is the message properties level. Several characteristics of instructional displays may be controlled by the instructional developer to attract the student's attention to certain elements of the message and help raise the rate of uptake of the information being presented. One variable is the use of media techniques as motivators and attention-getters. The videodisc has great potential in this respect because it is a highly visual medium and can be made interesting simply through the use of certain kinds of video displays. Secondly, a developer may manipulate language - the level of explanation and the level of technical jargon - to improve the student's reception of the message. Some otherwise well-designed instructional materials fail at this level because of a lack of sensitivity to the level of language, level of explanation, and technique of explanation used at the within-display level. There were several cases in the lessons developed for this project in which the developers felt major improvements were made at the display level simply by rewording or slight expansion and texturing of the message.

2.6.5 Summary. In summary to this point, it can be said that there were several levels of strategy decision-making. Many of these strategy decisions could have been made independently of the medium chosen for instruction. They are still, however, considered to be enhancements made to the original lessons and potential sources of learning improvement. Equally important, the strategy decisions were made the guidelines used in determining how to use the videodisc player capabilities to administer the MOS 31V10 lessons. Strategy decisions were not based primarily on the videodisc capabilities which were available. Instead, the videodisc capabilities were used as much as possible to implement the requirements of the strategies chosen. This is an important distinction which keeps a balance for this project between the need to explore capabilities and the need to produce instruction according to principles of effectiveness.

2.7 Videodisc Rationale. The control keys of the videodisc player were used in conjunction with special video display techniques to implement the strategies designed for each lesson and objective. The control keys available on the

Magnevox videodisc players are:

- Normal Play Forward
- Normal Play Reverse
- Slow Forward
- Slow Reverse
- Still Forward
- Still Reverse
- Fast Forward
- Search Forward
- Search Reverse
- Index
- Sound I/Sound II

An account of how these keys were used to implement the strategies already described is given in the sections which follow.

Normal Play Forward: The Play Forward key was the most frequently used key. Although one of the main virtues of the videodisc is its high volume storage of single frames, the great majority of lesson materials for this project involved the use of audio, which requires the playing of the frames at the normal rate of 30 frames per second. Single frame presentations were used, but not frequently during instructional messages. To control the rate of new information presentation, the Auto-Stop feature of the videodisc player was used in conjunction with the Play Forward feature to create program stops so that average message length was 5 to 10 seconds. Without the Auto-Stop feature, the consumer-model videodisc player would suffer the same difficulties as other single channel, linear media such as slide sound, where the user has no control over the rate of presentation of new information. As described in the previous section, the ability to break up the presentation in this way was supplemented by clear and logical explanations at the within-display level, and a conscious attempt was made to break the message at logically significant points.

Use of the Play Forward key made possible several within-display manipulations such as use of video techniques synchronized with video elements. This was especially important during parts of the lesson dealing with signal tracing, where a sense of motion and sequence was being established. Three lessons concentrated on this type of content, and since it was part of the lesson design to require students to use diagramatic material from the technical manuals, the illustrations used during these portions of the instruction were unavoidably complex. The ability to use the motion sequences for isolation and attention-directing techniques was very useful. Several different video techniques were used during the motion sequences for this purpose, including flashing position locators, animated sequences of signal path identification, and shading techniques to isolate attention to one feature of the picture.

Another use of the Play Forward feature was for presenting demonstrations in which motion was the key factor. During instruction on certain procedures, such as the changing of the link positions in Mounts MT-1898 and MT-1029, certain portions of the procedure were delicate. It was very useful during instruction on these procedures to be able to present demonstrations of that procedure being properly done.

The Play Normal key was also used to create timed drill-and-practice routines.

Since the normal rate of play of the videodisc player is 30 frames per second, segments of time were inserted into the presentation through the insertion of an appropriate number of still frames into the videodisc sequence. In Lesson 3, the inserted still frame method was used to give students a timed interval in which to produce a correct answer, following which the correct answer was produced automatically by the videodisc. An extract of that drill-and-practice routine is contained in Attachment 2.

In addition to the instructional features described above, it was recognized that, in general, properly used motion sequences themselves have motivating and interest-generating capabilities, especially when some of the more "grabbing" video techniques are used. Due to the size of the production task involved in these lessons and the work burden that would have been placed on production organizations, however, use of the Play Normal feature for this purpose was limited.

Normal Play Reverse: The Play Reverse key was not found to be useful in implementing the strategies designed for the lessons on this project, given the type of content involved in the lessons. No specific uses of the Play Reverse key were used to attain a strategic goal. However, since the consumer-model videodisc player lacks the branching capability, reviews of material must be obtained by manually retracing the instructional path to the beginning of the review area. This was recommended to the student in the introductory lesson on videodisc operation.

Slow Forward: Use of the Slow Forward key to achieve particular strategy effects was not a feature of the lessons. In the demonstration of intricate procedures involving careful timing, precise movements or highly coordinated movements, it is likely that the Slow Forward key would be very valuable. There were, however, no objectives with content of that type in the lessons developed.

Slow Reverse: Likewise, no use was made of the Slow Reverse key for strategic purposes. The rationale for this is similar to the rationale for not using the Slow Forward key and the Play Reverse key.

Still Forward: The use of individual still frames was common, particularly during lessons which involved several laboratory exercises. The instruction given to students for advancing from still frame to still frame in such cases, however, was to press the Play Forward key. The reasoning behind this was that the use of the controls for the student would be simplified if only one instead of two different controls was used to attain essentially the same visual effect for the student. Although mechanically the Still Forward key and the Play Forward key cause much different results within the videodisc player, the result to the student is essentially the same.

Still frames were used particularly during laboratory exercises and quizzes. These activities did not in any case require the use of motion sequences. The format for quizzes included the presentation of a multiple choice quiz question (the type of question specified as being most appropriate by the Contracting Officers' Representative) followed by the presentation of the subsequent frame with the correct answer, along with the question and the incorrect distractors.

Had more of the lesson material been presented on still frames, the Play Forward key could have been used to skip over large blocks of still frame material quickly to make a review. This capability was demonstrated in the introductory

lesson on videodisc player operation, but was never incorporated into the lessons, since lessons relied heavily on audio sequence, which requires a videodisc to be playing at the rate of 30 frames per second.

Still Reverse: No strategic use of the Still Reverse key was made in the lessons other than that which would normally be prompted by the student during self-initiated reviews.

Fast Forward, Search Forward, and Search Reverse Keys: These keys were not used to accomplish any instructional strategy goals. During the introductory lesson on player operation the keys were recommended to the student as a means of moving quickly to any roadsign embedded within the lesson, particularly one at the beginning of an objective for review purposes.

Index: The Index feature of the videodisc player was not used strategically, instead it was described to the student as a means of arriving at a specific frame on the videodisc for review purposes. Frame numbers for the start of each instructional objective in a lesson were provided to the student in the guidance package. By using the Index feature, the student could review any individual objective by proceeding to the appropriate frame and beginning the instructional sequence.

Audio I/Audio II: As originally proposed, use of multiple audio tracks was not made. The same audio message was recorded on both tracks where audio was used. Experience in making videodiscs with split audio tracks has shown that certain timing problems occur when different messages are recorded on Audio I and Audio II. If one message is slightly longer than the other, the pause at the end of the play sequence for the student receiving the shorter message quickly becomes irritating. The solution, writing messages of the exact same length, is extremely time-consuming and tedious.

3.0 Problems, Solutions, and Lessons Learned

In this section problems encountered and solved during the project are discussed for their potential benefit to future videodisc development projects. The lessons learned are organized under four major headings which correspond to major areas of concern for development projects:

1. Lessons learned concerning the planning, scheduling, and management of videodisc development projects
2. Lessons learned about the development processes related to videodisc courseware development
3. Lessons learned concerning instructional techniques used with the manual videodisc player
4. Lessons learned concerning special requirements during development and production of videodisc media.

3.1 Planning, Scheduling, and Management. During the course of the project, it was learned that several things could be done to facilitate the planning, scheduling and management of videodisc development projects. These are discussed in subsequent paragraphs.

3.1.1 Scheduling. It became apparent in the first few weeks of the project that the rate of lesson production called for in the Contract Performance Plan (CPP) did not allow adequate time for the authoring of lessons or for their review. This was due to several factors. Although SOW data provided an estimate of instructional time alloted to each lesson, that figure turned out to have an irregular relationship to the amount of time required for the authoring of each videodisc lesson. Troubleshooting exercises, for instance, turned out to have one authoring rate, while instruction materials tended to have another. Lesson 4, which involved the use of a job performance aid (JPA), required the development of the aid before the development of the lesson could proceed. This also had its own authoring rate. It was difficult to determine in advance a realistic schedule for the authoring of an individual lesson.

The solution adopted for this lesson was to pursue the project schedule milestones as efficiently as possible; at the same time, accepting the fact that the work burden was larger than estimated. This ultimately led to extending the contract due date. As work proceeded under this arrangement, it was found that on the average the rate of output for a given worker on a given type of product was more or less constant over time. It was found that there were certain finite limitations on the amount of quality material a person could produce in a unit of time, given the inputs to the authoring process and the form of authoring system being used.

The lesson learned for future projects in this instance was that there is a need for tools to make more accurate estimates of expected workload and manpower requirements during the schedule planning process. The form of tool recommended is a set of work task and manpower standards which would show average manpower time requirements for given products by worker category.

Additionally, the CPP, once arrived at using such a tool, should be tested against this set of work time standards before acceptance to determine if it is truly realistic. It is a great temptation for developer and manager alike to agree on time schedules simply because they "sound right" or because it "feels" like the work should be completed in that period of time. Care should be taken during work plan review to see that sequential activities which must occur in order are reckoned in terms of the total elapsed time that will be required to complete them, rather than the total allocated manpower time. Too often the temptation is to determine total manpower requirements based on total man-days expended, rather than on total man-days expended over a chronological period. It is very often the case that a total man-day figure will be used in setting schedules. The false logic of this approach should be readily apparent since any time a person spends waiting on the output of another person under such schedules advances the completion time of the product by that amount.

A sample of the type of task x manpower matrix recommended is presented in Table 5 (page 17). This table contains data on the production of a specific variety of workbooks. The workbooks have a known average length, illustration density, and layout. The columns of this matrix name development personnel required for the production of instructional media. The rows name the phases of production needed to create the product. The man-hour entries on the table indicate the time required to execute the production of the presentation. To find out the estimated manpower required to produce one of these items, the columns should be added. This matrix shows that .78 man-days of Instructional Psychologist (IP) time are required, .65 man-days of SME, and .71 man-days of Scriptwriter/Editor (SW/ED). For five of such workbooks, the estimated manpower figures would be 3.9 man-days of IP, 3.25 man-days of SME, and 3.55

TABLE 5

A MANPOWER x INSTRUCTIONAL PRODUCT REQUIREMENTS
MATRIX FOR ONE VARIETY OF WORKBOOK

	INSTRUCTIONAL DESIGNER	SME	SCRIPWRITER EDITOR	TAPE/SLIDE ARTIST	TAPE/SLIDE ARTIST	TECH ARTIST	PHOTOGRAPHER	PROOFREADER	NARRATOR	WORD PROCESSOR OPERATOR	PASTE-UP
	1	2		3	3	3				4	
AUTHORING	0.13/ 0.13	1.13/ 0.13				5 0.25				5 0.5	
PROTOTYPE PRODUCTION	0.13	0.13	0.13	0	0	5 1.0	0	0.13	0	0.13	0.25
TRYOUT	0.13	0	0.13	0	0	0.5	0	0	0	0	0
REVISION	0.13	0.13	5 0.25	0	0	0.1	0	5 0.13	0	0.13	0
FINAL PRODUCTION	0.13	0.13	5	0	0	5 0	0	5 0	0	0.25	0.25
TOTAL	0.13/ 0.65 .78	0.13/ 0.52 .65	0.75	0	0	1.85	0	0.26	0	1.01	0.5

NOTES:
1 Double entries in this column: Interview time/consolidation time
2 Double entries in this column: Interview time/research time
3 Breakdown of categories due to project staffing constraints or needs
4 Secretary time from attachment 3 is contained in word processor totals
5 Estimate varies slightly from attachment 1 data due to peculiar project conditions or instructional formats.

man-days of SW/ED. These figures, of course, should be subjected to a chronological period over which these man-days would be expended. If actually obtained values are found to differ from original planning values, the matrix can be updated, and fresh calculations can be made.

In addition to planning schedules realistically based on estimated manpower production rates, future development projects, particularly ones that utilize government personnel for either review or SME or production purposes must take into account the effects of holidays, annual leave, and auxiliary duties on the performance of the personnel assigned to the project. It must be insured that the time actually devoted to project work in a schedule be a realistic assessment of the manpower actually available. Particularly dangerous times for projects involving government personnel are holiday seasons and vacation periods when many facilities run on reduced manning schedules or have a heavy absentee rate.

3.1.2 Long Distance Communication. The schedule for this project was quite fastpaced and required a high degree of interaction between members of the contractor team and various members of government organizations. These communications very often involved the exchange of extensive amounts of script or visual material, following this there was a requirement for review and then a requirement for passing the script material back to the originator. Problems arose during the contract when bulky materials were required to travel through both postal services and organizational mail rooms only to arrive later than expected. The return mailing only compounded their lateness. It was a surprising finding of this project that even the "overnight" mail services commercially available were restricted in their delivery locations and that deliveries were sometimes made to incorrect places, increasing the delay of delivery.

A satisfactory solution to this problem was not found during this project other than building into schedules realistic amounts of time for travel in the mails. This was a factor in the lengthening of the schedule and should be a factor in future projects, whose planning should also include adequate and realistic mail delays and should avoid schedules so closely synchronized that the delay of one item in the mail would disrupt other scheduled activities.

3.1.3 SME Organization. For highly technical training, as military training usually is, the provision for SME coordination with the developer is a critically important issue affecting the developer's ability to produce the product. Development projects have in the past attempted a broad variety of organizations, utilizing SMEs from a variety of sources in an attempt to find the organization which best serves the needs of all parties involved.

The subject-matter expertise for this project can be said to have been supplied from three sources: (1) from a contractor employed SME who was at the time of his service separated from the military, (2) from existing lessons supplied as GFM at the outset of the contract, and (3) from technical reviews of the material by government SMEs. For the purpose of this project, the subject-matter expertise was supplied in a manner which assured technically correct materials with a minimum of convenience, though initial estimates of SME manpower required were highly over-optimistic. Key factors in this were the clear definition of content in the existing instructional materials and the clear focus of the project which precluded massive reorganization or redefinition of content.

Most instructional development projects, however, do not have these features. It is important in planning future videodisc development projects to insure adequate SME support and to insure that the subject-matter expertise is fully qualified, has adequate access to documentation, and has adequate access to development personnel. Several varieties of organizations are possible, including (1) the use of military SMEs who supply data according to formats specified by the contractor, (2) contractor employed SMEs who are given adequate military support through access to documentation, updated policy, and technical data, (3) creation of subject-matter expertise through the training of development personnel in the content, or (4) creation of developers from SMEs through training in development techniques. Of these four alternatives, (3) and (4) are not recommended, except in rare cases. The alternative (1) approach has the potential of being more successful in instructional development projects than the others. It is to train SMEs in basic, highly-controlled and proceduralized writing techniques which then are used under the control and review of developers. Development pursued in this way often has the benefits of greater responsiveness to target population characteristics and styles, greater technical accuracy, heightened credibility, and greater support from the authors themselves. Also, the interface formed between developer and SME under this development organization is characterized by much better communication and understanding of the materials by the SMEs. This increased communication usually insures that a developed product will result which is more aligned to the needs and desires of the client. Usually under this organization there is also a greater understanding by both sides of the rationale for the product.

3.1.4 Creative Interaction of Production Staff. The complexity of the process of making the instructional videodisc has been alluded to earlier in this report. The videodisc, because it combines the capabilities of several media, among them the more sophisticated media such as videotape and synchronized audio effects, requires detailed planning and preparation prior to production.

Professionalism in videodisc production requires careful coordination of styles, insurance of continuity, planning of video effects, and synchronization of multiple production elements in order to produce a quality product. The organization of the present project, which included a contractor working at a distance from the video production agency and standing between the artist and the video production agency, could easily have become problematic had not the production sheet forms used in storyboard writing been employed to convey the greater amount of information necessary to coordinate production expectations. The television technicians involved in the project were highly skilled and competent to produce the videotapes and were also skilled in video production techniques. Had not this been the case, even with the increased communication carried out through the production sheets, the production would have been perhaps an overwhelming task. A review of each script was also provided by TVB personnel during the project. This review added greatly to the communication between the contractor and the video organization.

As it was, the problems most commonly encountered by the project were specification of impossible or inappropriate video effects, including at different times the following:

- attempts to put too much detail into visuals
- attempts to put too much text on the screen at once
- improper use of colors and color contrast
- improper use of specific video equipment owned by TVB

- requests for effects not possible using TVB equipment
- requests for video effects which "seemed" good but did not play well

The lesson learned with respect to project organizations from this experience is that even with a high level of communication made possible through the production sheet forms, additional communication coordination and planning between authors and television technicians was desirable. A set of procedures for developing interactive videodiscs is presented in Attachment 3. It can be seen from this process statement that the videodisc-making process is a highly interactive process involving authors and video technicians as well as program managers. This interaction begins early in the life history of each lesson script so that maximal input can be obtained from video production personnel.

It is recommended in the future that projects be staffed in a more integrated fashion to provide for earlier coordination between authors and producers. This may be achieved either by establishing totally in-house or totally contracted development efforts or by establishing a set of guidelines for the purpose of directing the joint activities of authoring and video teams early in the development and continuously throughout its course.

3.2 Development Process Level. Several important lessons emerged during this project related to the instructional development process. Even though the development of videodiscs requires specialized skills, equipment and facilities, it nonetheless does not rely any less heavily on systematic development practices in order to produce instructionally effective products. This section describes the lessons related to those development processes.

3.2.1 Focus of Instructional Objectives. During the normal instructional development process which would involve analysis prior to design, analysis products would be created naming terminal behaviors or "tasks" which were the target for the training system. From these tasks, additional instructional goals or objectives would be defined having a high degree of relevance to those terminal tasks and a close approximation to their behavior. Were this done conscientiously, the net result would be a set of instructional objectives and training tasks which approximate closely to job-like behavior. Those behaviors practiced by the student during instruction, therefore, would be very close to the behaviors the student would ultimately be required to carry out on the job. This is a desirable condition, since it eliminates mostly "verbal" objectives and elevates most objectives to a more sophisticated level, having more relevance to real world performance. During the course of this contract the contractor had originally hoped to elevate the objectives in the lessons from the memory level to the performance level with more job-relevant behaviors being the target condition. To some extent this was achieved, but by no means to the extent the contractor felt was appropriate and desirable. In the proposal, the contractor made an estimate of the mixture of instructional objectives in the lessons to be developed. The projected percentage of each variety of instructional objective, by behavior type, is shown on Table 6 (page 21). The table shows that even though many of the objectives (41%) were expected to be memory-level objectives, the majority (59%) were expected to be nonmemory-level objectives, intended to be more job-relevant. The need to keep objectives at the same level as in the original instruction materials was a limiting factor, however, and the final disposition of instructional objectives in the actual lessons is recorded on Table 7. It can be seen that the large majority of instructional objectives remained at the memory level.

TABLE 6

OBJECTIVE x CATEGORY
BREAKDOWN AS ESTIMATED
BY THE CONTRACTOR

Category of Objective	# of Obj.	Total	Percent
Non-serial memory	6		
Serial Memory	1	9	41%
Associative memory	2		
Procedure	8	8	36%
Classifications	2	5	23%
Rule-using	3		
Total	22	22	100%

TABLE 7

ACTUAL OBJECTIVE x CATEGORY
BREAKDOWN
ACHIEVED IN THE LESSONS

Category of Objective	# of Obj.	Total	Percent
Non-serial memory	12		
Serial Memory	7	26	62%
Associative memory	7		
Procedure	11	11	26%
Classification	2		
Rule-using	3	5	12%
Total	42	42	100%

It is felt that the high reliance on memory training is not a desirable precedent for military training. It is true that during training of complex skills and knowledges a variety of facts and memorized information are required to be learned. Nonetheless, it is well understood by developers that instructional objectives are prone to fall to the verbal level in the average training course. It is easier to train that way, but it is also less relevant. The lesson learned from this project concerns the importance of analysis prior to instructional design and development and the use of that analysis to produce job-relevant training tasks and objectives. The analysis process is often bothersome to developers who are anxious to produce media products. Nonetheless, our experience in this project and on other projects only underscores the importance of an analysis prior to the development of training. In future videodisc development projects, even though the emphasis may tend to be on the videodisc, the lessons learned from this project stress that importance should be also placed on the analysis process and on obtaining analysis products which will assist the developer in creating the most relevant instruction possible.

3.2.2 Tryouts. The empirical testing of instructional materials developed during the programmed instruction era and later given the name of "formative evaluation" and more recently called "material tryouts" is an important process in the development of instructional presentations. The lack of opportunity to try out instructional materials was a problem whose effects were felt keenly during this development project. It is during the tryout process with small groups of representative students that it becomes clear to the developer whether the language, technique, and style adopted in the instructional materials are appropriate to the target population. Although a great deal of design can take place in advance, the developer is never really sure how well materials have hit the target until they have been tried out. For this project the postcontract evaluation of videodisc lessons will constitute a try out, but one in which it will be difficult to recover should the expectations of the authors prove wrong.

One lesson learned during this project was that in future videodisc projects careful evaluation of the product prior to production of the disc must be required. There are several levels at which instructional presentations may be tried out from the very unsophisticated 4 x 6 card method, with one student sitting across the table from the developer, to more sophisticated videodisc authoring and review systems, which presently do not exist as such but which are being developed for the purpose of obtaining realistic reviews not only for student purposes, but for the developers' perception of an emerging videodisc project.

3.2.3 Maturing Content. Training problems which come to instructional developers for solution are rarely "training only" problems. Instead these problems usually involve a mixture of management problems, organizational problems, and doctrinal problems. Among the doctrinal problems is the lack of doctrine or the fuzzy specifications of doctrine. When the doctrine to be trained is not clearly spelled out, it is virtually impossible for clear and unequivocal training to be given to students based on that doctrine. Because most development projects contain a mixture of all of these types of problems including the doctrine problem, the developer usually solves, helps to solve, or causes the sponsoring organization to solve the problems, and so the content of instruction very often changes even while the instruction itself is being written.

It would be difficult to name very many development projects which did not

experience the doctrinal problem being solved, or to put it more broadly, it would be difficult to name very many development projects in which the content of the training did not change at some time during the development of lessons. This is not only true in well-established areas in which the content is relatively stable, but is especially true of high technology skills and weapons areas in which the content can change literally weekly.

Although development projects almost universally encounter the doctrine problem being solved during the course of the project, very few development team agreements have provisions to deal with these problems. The resulting effect on the product varies depending on the relationship between the developer and the client. (One of the lessons learned on this project was that the content matured during the writing of Lesson 4, and later during the writing of Lessons 6 and 7, just as might have been expected.)

The message to future development projects is to: (1) Plan and analyse more thoroughly before project initiation to be sure the stability of content and even anticipated content change dates are known. (2) Be ready for the changes by building "changeability" into development process. This can be done by putting developing scripts on a word processor and by planning scripts to be modular or compartmental so that changed portions can be identified and revised easily and without massive effects on the rest of the presentation.

3.2.4 Emerging Content. A problem closely related to the maturing content problem described above is the "emerging" content problem which was experienced on this project as well as on many others that the contractors are familiar with. Whenever newly developed instructional materials must improve the instructional "impact" on the students, one of the methods of obtaining that improved impact is very often the filling in of "gaps" in the original instruction. Early instructional technologists, hoping to support their position through developing more efficient products, often found themselves having to cope with the difficulty of training more content than the original instructional presentations. They found that it was not entirely faulty instructional technique or inefficient media which led to low student achievement. Sometimes it was simply the lack of instructional content in the lessons sufficient to convey the needed information to the student.

It is not uncommon for the developers using old instructional materials as a guide for the development of new ones to spot gaps. These gaps may require explanations to be made of facts to be presented beyond what is in the original materials. These gaps require the addition of material to the instruction rather than deletion of material from it.

In the course of this project, there were numerous cases in which the developers found it necessary to add to the bulk of the lessons in order to provide adequate explanations of key ideas. In large-scale development projects, this would become a large problem, affecting the total cost of the development. In future videodisc development projects, particularly those of larger scale, it will become important to carefully inspect existing instructional materials in the light of analysis performed and in the light of anticipated instructional strategy before estimating the magnitude of the work called for. If this is done, the developing organization can more closely calculate the actual level of effort needed for the development and will suffer fewer surprises as content "emerges" during the process of writing.

3.3 Instructional Technique. Some of the problems recognized during this project were related to the employment of instructional techniques.

3.3.1 Audio Volume. During this project, because of the assumption made that students in the MOS 31V10 course would respond better to audio-presented information than textually-presented information, the main message of instruction was applied through the audio channel and augmented through the visual channel. The problem arising from this decision is the large amount of disc space covered per second when audio is used. Each half-hour lesson fills one side of a disc of the type developed for this project, and several of the lessons developed for this project were longer than one-half hour. The solution accepted for this was simply to accept the requirement for the large number of discs.

The potential lesson in this for future videodisc development projects is that the developer must be clever in finding ways to economize frames on the videodisc if the audience requires a high volume of audio presentations or if the content and strategy demand a high volume of motion video presentations. There are several techniques through which compaction of the space used may be achieved; for instance through reuse of common video sequences throughout the lesson. The computer-controlled videodisc, if used, would enhance the developer's ability to use and reuse motion sequences in both normal, fast, and slow-motion to some instructional benefit. In the long view, developers may look forward to the creation of high volume random access audio storage devices or may even look for more sophisticated media than the videodisc but, until then, careful planning and fitting of lessons must be the rule where high amounts of audio or motion video presentations are required. One possibility is the presentation of sequences of still frames which simulate motion sequences with only a small fraction of the frames being used. This might be called "stop action motion" and could utilize the Slow Forward key with the speed control slide set at one of the slower settings. This would give the effect of motion on videodisc without demanding a high volume of frames. It would not, however, allow audio to be used.

3.3.2 Media Limitations. The consumer-model player is a surprisingly capable medium on which, with a little effort, the instructional developer can defeat the linear nature and utilize some of the powerful directed branching/immediate access capabilities of the videodisc itself. During the introductory lesson on videodisc player operation, students were given a simulated golf game in which their objective was to find the hole at a given location or a given number of control manipulations from the frame where they started. This appeared to be a highly interactive use of the videodisc player and certainly exhibited all of the operating characteristics of the player. The manipulations of the player were highly relevant during the instruction since the instruction was on how to manipulate the player. Such varied use of the controls could have been executed in other lessons also but was not seen as having the same strategic purpose. Therefore use of the broad range of controls was restricted in later lessons. This is not to say that there was no desire from the developer to use more sophisticated moves. It is to say that the moves desired were not included in the set of those easily attained using the consumer-model player.

In the course in preparing those presentations, there were many instances in which the desirable features of the strategy plan had to be curtailed due to the limited ability of the manual system.

The medium has not been invented yet which satisfies all the desires of developers. The consumer-model videodisc player shares the characteristics in common with all other instructional media in that it is limited in some aspects of its performance and would be capable of administering more sophisticated instructional strategies if computer control were added. The lesson to be learned from this is that just as the capabilities of the videodisc have been explored to some extent in this project, future projects should explore the utilization of the computer-controlled videodisc and study the instructional strategies possible on one but not on the other.

3.3.3 Strategy Limitations. An earlier section described the difficulties inherent for the developer in developing in the absence of appropriate analysis procedures, and the previous section has just discussed limitations of the consumer-model disc player in representing the broadest range of instructional strategies. These factors combined to produce a problem for this project related to the particular method of implementing instructional strategies during the authoring process. The problem that was experienced was a loss of authoring economy due to the inability to define standard strategic information categories which could be used to "build lessons."

Through the use of standard strategic information categories experience has shown that economies of scale may be achieved in the writing of instructional materials.

The original design of Time-Shared Computer-Controlled Informational Television (TICCIT) Computer-Assisted Instruction (CAI) system was the first major effort to capitalize on strategic display types as the basis for authoring instructional materials. Special keys were used on that system to call for specific "types" of display, all under full student control. Experience since the TICCIT system in several instructional media including workbook, slide-sound presentation, and videodisc has shown that taking the componentized informational approach to authoring of instructional materials almost always improves the efficiency of the authoring process, even enabling the authoring process to be delegated to nonwriter SMEs. In order to construct lessons which utilize the display-type strategy mechanism fully, it is desirable to work with objectives which are above the memory level and out of the verbal domain. And it is desirable to have a media system sufficiently sophisticated to branch students either at their own request or based on some calculation to a particular display type at any given time.

The foundations for using this type of strategy on this project were laid in preproject documentation provided by the contractor concerning objective types and strategy manipulations which the contractor favored. In some lessons, use of these display types in appropriate strategy structure was achieved. This was particularly true in certain drill-and-practice routines and in certain example/nonexample routines during Lesson 3. On the whole, however, it was very difficult to achieve many strategies due to the media limitations and memory-level objective problems. In a way, the lesson learned here does not confine itself to the project level, but rather is a lesson about media devices themselves. At the outset of the project, the consumer-model videodisc player was state-of-the-art, and computer controls had not been introduced. The developer and client were content to press the medium for all it could do. During the course of the project, the computer-controlled videodisc not only emerged, but it eclipsed the consumer-model player because of its superior branching and computing capabilities.

Despite this turn of events, it is felt that the consumer-model videodisc player was well-tested in its capabilities by the lessons and that several creative things were found possible using it. Certainly there are many more which will be found. Instructional psychology is fast approaching a position of being able to implement complex and precisely controlled instructional strategies. Developers are constantly calling for more sophisticated media capabilities. It is anticipated that the videodisc will distinguish itself in assisting to carry out many of these strategies under the control of a computer, but this project shows that many things can be done without it as well.

Another lesson that this problem points out is that the particular authoring system used on a given project must be tailored to the needs and resources of that project. The originally anticipated authoring process for this project was based on the objectives mix in the proposal and did not anticipate some of the limitations encountered. Future development projects should seriously consider the form of the authoring system they choose to implement during authoring and should realize that the economies that can be affected during authoring and standardization of techniques depend a great deal on the type of objectives being taught and the sophistication of the strategies employable.

3.4 Instructional Media and Development Technique. Some problems of this project were related to instructional media productions and development techniques, since the videodisc is in some ways a much differnet medium to produce.

3.4.1 Production Data Demands. The increased demand for production data during videodisc production has already been pointed out, and the system for recording that data on production sheets has been described in a general way. It is felt that the storyboard system adopted for this project has the benefit of consolidating in one place the data needed for production by a variety of users, including production personnel, authors and reviewers. Experience on the project also showed that specialized production lists could be summarized from the storyboard forms to guide work assignments and to aid management on the production process. These production lists have been described earlier and samples have been given. Mention of the storyboard system is made again at this point to emphasize the criticality during videodisc production of adequate informational exchange and coordination between production team members.

3.4.2 Adjunct Aids. Through common usage, the more traditional media forms such as books, magazines, charts, etc., become "readable" to the user because of a set of scanning habits and conventional structural parts such as tables of content, indexes, and chapter divisions, which allow the user to feel oriented and comfortable regardless of what part of the medium presentation is being used. For instance, students do not normally feel "lost" simply because they are on page 57 of a book. They normally carry with them some sense of where page 57 is in relation to other major book landmarks. For a new and less-known medium like the videodisc which does not have customary memorized or habitual landmarks as far as the user knows, there may be a sense of "drowning" in the medium and a claustrophobic reaction as the student realizes that orientation has been lost. To assist in this problem, roadsigns described earlier were built into lessons. In addition, guidance packages were created for each lesson which contained not only a carry-away summary of the lesson, but also a list of videodisc landmarks which the student could move to rapidly for instructional or review purposes. These landmarks consist of the beginning points of each instructional objective. Future videodisc development projects which use the consumer-model videodisc player should be attuned to the likely reaction of students

who are left without landmarks. Adequate adjunct aids should be provided to keep the students oriented and to provide memory and reference for all portions of the presentation.

3.4.3 Use of Play and Still Forward Keys. The Play Normal key was used almost exclusively during the lessons developed as the means for advancing from one display to the next. Since most of the displays in the lessons developed were motion video sequences, this meant advancing from the end of one motion sequence to begin playing the next. The Play Normal key was appropriate for this use, and a small message in the lower right corner of the screen informaed the student when to press Play to advance the presentation.

To simplify the use of the keys for the student, it was decided to use the same key to advance to still frames. That way the student did not have to refer quite so diligently to the message at the bottom of the screen. The Play Normal key was found to work in this application, but an undesirable side effect was that a too-lengthy press of the key could send the student ahead several still frames. It was decided in later lessons, especially those involving laboratory exercises and thus large numbers of still frames, to specify for the student to use the Still Forward key when moving to a still frame to avoid frame jumping.

4.0 Recommendations

This section of the report summarizes the previous section by drawing out of it recommendations based on the lessons learned during this project. These recommendations range from suggestions for revised methodologies for contracting for development services to specific suggestions for future videodisc project directors. Since the arguments in favor of each of the recommendations have already been presented in the previous section, each recommendation is presented in an abbreviated form below, in the form of a recapitulation.

1. It is possible to greatly improve the level of detail and specificity with which work expectations are stated between developers and clients. The common practice of stating expectations in terms of objectives or time of instruction only have meaning if all who use the terms have a common defining referent. Without much effort, a set of referent task-by-manpower standards could be published as a basis for cooperating agencies to use in developing work schedules and staffing plans. These standards could be used to specify (1) the individual products requiring development, and (2) the relative size of effort involved in each. A set of common standards would not only aid developers in making schedules but would aid those evaluating the schedules to be sure that they were realistic. A set of standards would mean that misestimates and the attendant schedule renegotiations and disruptions of work could be avoided.

2. Standards should be developed for the creation of work plans that specify to the developer how to make a plan that represents realistic scenarios. These plans should take into account periods of work when key personnel will be unavailable for use and should not allow work schedules to show that work will continue as if they were. They should also take into account the sequential nature of most work and not estimate time schedules based on man-hour expenditures, but rather on chronological requirements of the work. These plans should also take into account the actual amount of time it takes to deliver products, especially bulky ones, through the mails.

3. The modes of organizing the SME element of the development team should be given careful study in the future. Variations in organization should be studied on a number of projects involving SME support from a variety of resources. Guidelines should then be developed for the selection of SME support for different projects given the factors surrounding the projects and resources available. Guidelines should be able to identify support situations likely to lead to decrements in product quality or delays in scheduled work.

4. Guidelines should be developed for the integration of production personnel and developer personnel at all stages of projects which involve heavy commitment of production, such as in the production of videotapes. Process descriptions to govern interactions should be clearly written and complete and should describe the early interaction of production agencies with the developer.

5. Projects for the development of instructional materials should not be undertaken which do not call for adequate amounts of effort in each phase of the instructional systems development process as described in the military instructional development regulations promulgated by each service. Clear and complete standards for development processes and products should be published and enforced for all development projects.

6. Flexibility should be built into agreements for instructional development to protect both the developer and client from unexpected shifts in the magnitude of the work effort and from the effects of changes brought about through the design process. Development of instructional systems, when done according to the systematic development procedures, is a process which first defines the training problem, then defines a solution, then produces the solution. Agreements are generally made for all of these processes at once. Under these conditions, there is no opportunity for results of analysis processes, or the results of the design process to disregard an already-fixed pool of resources. This hampers the design of creative and innovative solutions to training problems.

One possible pattern to avoid this constraint would be to divide the development agreement into several sub-agreements, one for each of the major phases of the development process. Between each phase, there would be a no-work review period in which the products of the completed phase were reviewed. Reviews would judge desirability of proposed designs, feasibility, and would allow participating organizations adequate time to acquire the organizational support and resources to pursue subsequent development phases. At present, plans and designs from one phase of a development project are being reviewed at the same time that work must begin on them due to constricted schedules and the lack of a review period following the production of the design. This recommendation may require longer-based projects in terms of time expended, but should not increase costs.

7. Studies of the videodisc, both computer-controlled and consumer-model, should continue to find the types of training environment best suited to each and the best modes of application of the devises to instruction. These studies should cover a broad variety of subject areas and training environments and should also deal with a variety of populations.

8. In the course of these studies, the improvement of the systems for authoring, reviewing, and trying out videodisc materials should be a companion

concern. Automation of the storyboarding process should be considered as one of the first steps, followed by the development of a system for the review and tryout of videodisc material prior to its production in disc form. These systems are not beyond the technology and could be constructed in simple forms at first, leading to more sophisticated authoring support and management systems in the future, making videodisc as a medium more accessible to development organizations not now prepared to produce it.

ATTACHMENT 1

Sample Production Support Documentation

NARRATION SCRIPT

Lesson 6 (8-4-1) page 1

Prod. Sheet	Narration
1	(music 5 second)
2	(music continues 5 seconds)
3	(music 8 seconds, then fade)
4	In the last lesson you learned that the AN/VRC-47 consists of six basic circuits. . .
5	. . . and you learned how the steps in the equipment performance checklist helped you identify which of the six basic circuits was faulty.
6	Then you learned to use the radio set's coding diagram to trace the defective circuit and make a list of all components, cables, and accessories that could be causing a wrong indication during performance checks. (Pause 1) Now you are ready to learn to troubleshoot each of the six basic circuits, one at a time.
7	This lesson, and the one that follows it, will cover two of these circuits. This lesson covers the radio set's DC power input circuit. The next lesson will cover the RT's antenna's matching unit control circuit.

Figure 2

Sample Narration Script Page

SOURCE

Lesson 6 - Final VIDEOTAPE LIST

Motion or Still	Production Sheet No.	Description	Tape No.	Begin SMPTE	End SMPTE
	10	Live shot of AN/VRC-47 radio set with mounts and cables showing.			
	38	Instructor demonstrating correct folding of diagram book R-100.			
	39	Live shot of R-100, page 19.			
	57	Live shot of R-100, page 21.			
	96	Live shot of JPA opened at Steps 1, 2, and 3.			
	97	Soldier turning RT's power switch ON to light dial lamp. Rushing noise is heard. Matching unit's clicking sound is heard.			
	98	Soldier turning power switch ON, but dial lamp does not light; no rushing sound heard; no matching unit click.			
	107	Soldier turning RT power switch OFF.			
	108	Soldier removing RT from its mount.			
	109	Soldier turning appropriate dials on multimeter			
	110	Soldier measuring voltage at pins A and B of J24 of MT-1029.			

Figure 3
Sample Videotape Production List

SOURCE PROPS LIST

Production Sheet #	Description
10	AN/VRC-47 with mounts and cables showing.
38	R-100.
39	R-100, page 19.
57	R-100, page 21.
96	JPA.
97, 98	RT-524, MX-6707.
107	RT-524.
108	RT-524, MT-1029.
109	Multimeter.
110, 111, 112	Multimeter and MT-1029.
114, 115, 116	Multimeter and battery.
117-120	MT-1029.
121-123	Multimeter, mount MT-1029, cables and battery.
127	Guidance Package, page 4.
162	RT-524 and R-442.
164-166, 168-175, 177	R-422 and MT-1898.
179	RT-524 and R-422.
181, 182	MT-1898
183, 188	JPA.
189, 190	RT-524 and MX-6707; See PSN's 97, 98.
193	RT-524. See PSN 107.
195	RT-524 and MT-1029. See PSN 108.
197	Multimeter, See PSN 109.
199	Multimeter, MT-1029. See PSN 110.

Figure 4

Sample Props List

ART REQUIREMENTS LIST

Art Number	Production Sheet #	Description	Out to Artist	In from Artist	Accepted
6-1	6	Base art: AN/VRC-47 basic circuits.			
6-2	10	Two large arrows.			
6-3	11	Radio component and voltage source.			
6-4	12	New component, radio component, and voltage source in direct power set-up.			
6-4/1	12	Overlay #1 shows application of voltage to radios.			
6-5	13	New component, radio component, and voltage source in remote power set-up.			
6-5/1	13	Overlay #1 shows switch in closed position with application of voltage to both radios.			
6-5/2	13	Overlay #2 shows switch in opened position with application of voltage to first radio only.			
6-6	15	"A" RT and voltage source.			
6-7	16	"A" RT circuit.			
6-7/1	16	Overlay contains signal flow.			
6-7/1	17	Same as PSN 16.			
6-8	18	"C" RT, "A" RT, and voltage source.			
6-9	19	"A" RT and "C" RT circuits.			
6-9/1	19	Overlay contains signal flow for direct power input.			
6-9/2	20..	Overlay contains signal flow for remote power input.			
6-9/2	21	Same as PSN 20.			

Figure 5

Sample Art Requirements List

ATTACHMENT 2

Extracts From a Timed Drill-and-Practice Routine

Production Sheet No. 134

Lesson_____ Segment_____ SMPTE( ) __ __ __ to __ __ __
Compositor Cartridge-Page _____ Estimated time (second)_____
Branch on_____ To_____

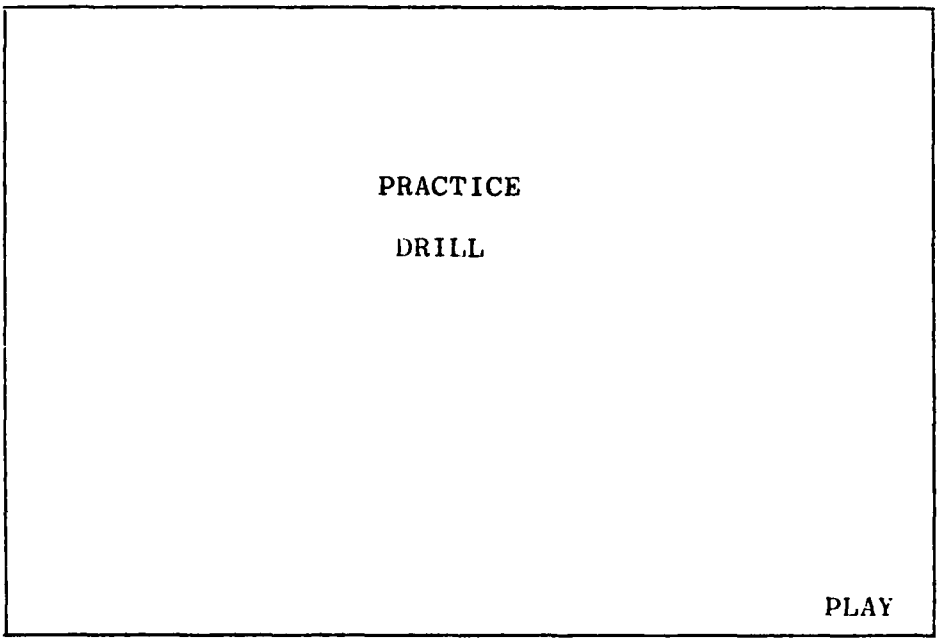
GRAPHICS: __Prop __Art __Photo No._____ NOTES_____

VIDEO: __Still __Motion Tape( )__ __ __ to __ __ __ NOTES_____

COMPOSITOR: __External X Text __Animation NOTES_____

STUDIO: __Split __Quad __Window __Highlight NOTES_____

PROGRAMMING: X Stop Calc Frame No._____ Actual_____



AUDIO: Now we are going to give you a chance to practice all of the alphabet at once in one big drill. You may take this drill as many times as necessary for you to learn all of the letters. Just remember to come back to this color frame. (Pause 1) Now, when you hear and see a letter, you will have three seconds to say the right word quietly to yourself. That three seconds probably won't be enough the first time through, but the last time you take the drill, it will probably be too long. Press PLAY when you are ready to begin.

Production Sheet No. 135

Lesson_____ Segment_____ SMPTE( ) __ __ __ to __ __ __
Compositor Cartridge-Page _____ Estimated time (second)_____
Branch on_____ To_____

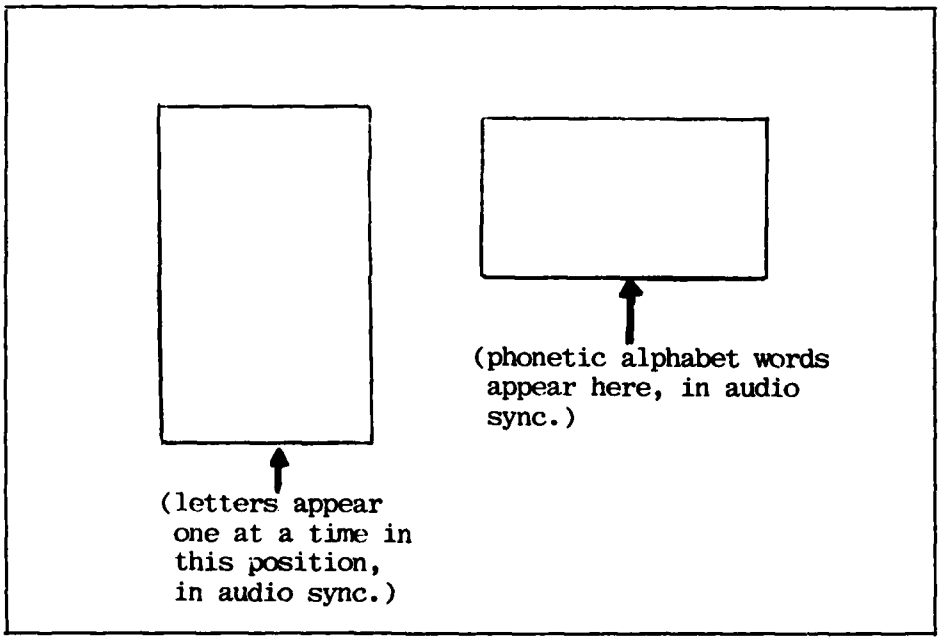
GRAPHICS: __Prop __Art __Photo No._____ NOTES_____

VIDEO: __Still __Motion Tape( )__ __ __ to __ __ __ NOTES_____

COMPOSITOR: __External _X_Text __Animation NOTES_____

STUDIO: __Split __Quad __Window __Highlight NOTES_____

PROGRAMMING: __Stop Calc Frame No._____ Actual_____



AUDIO: B (Pause 3), Bravo (Pause 1), P (Pause 3), Papa (Pause 1), Y (Pause 3), Yankee (Pause 1), G (Pause 3), Golf (Pause 1), L (Pause 3), Lima (Pause 1), S (Pause 3), Sierra (Pause 1), D (Pause 3), Delta (Pause 1), W (Pause 3), Whiskey (Pause 1), Q (Pause 3), Quebec (Pause 1), C (Pause 3), Charlie (Pause 1), Z (Pause 3), Zulu (Pause 1), R (Pause 3), Romeo (Pause 1), A (Pause 3), Alfa (Pause 1), H (Pause 3), Hotel (Pause 1), I (Pause 3), India (Pause 1), U (Pause 3), Uniform (Pause 1), K (Pause 3), Kilo (Pause 1), E (Pause 3), Echo (Pause 1), X (Pause 3), X-Ray (Pause 1), T (Pause 3), Tango (Pause 1), F (Pause 3), Foxtrot (Pause 1), J (Pause 3), Juliett (Pause 1), N (Pause 3), November (Pause 1), V (Pause 3), Victor (Pause 1), M (Pause 3), Mike (Pause 1), O (Pause 3), Oscar (Pause 1).

Production Sheet No. 136

Lesson_____ Segment_____ SMPTE( ) __ __ __ to __ __ __
Compositor Cartridge-Page _____ Estimated time (second)_____
Branch on_____ To_____

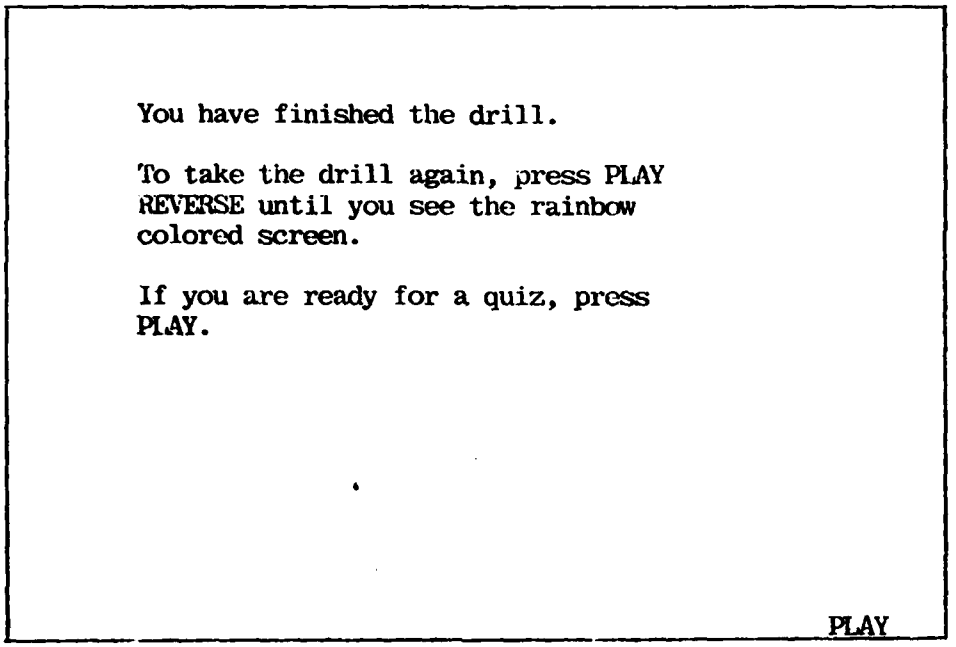
GRAPHICS: __Prop __Art __Photo No._____ NOTES_____

VIDEO: __Still __Motion Tape( )__ __ __ to __ __ __ NOTES_____

COMPOSITOR: __External _XText __Animation NOTES_____

STUDIO: __Split __Quad __Window __Highlight NOTES_____

PROGRAMMING: _XStop Calc Frame No._____ Actual_____



AUDIO: _____

ATTACHMENT 3

WICAT'S Videodisc Production Process

Major Steps in Videodisc Production

WICAT Systems

Steps requiring the Subject Matter Expert are marked: ◯

Steps requiring the IT/Writer are marked: □

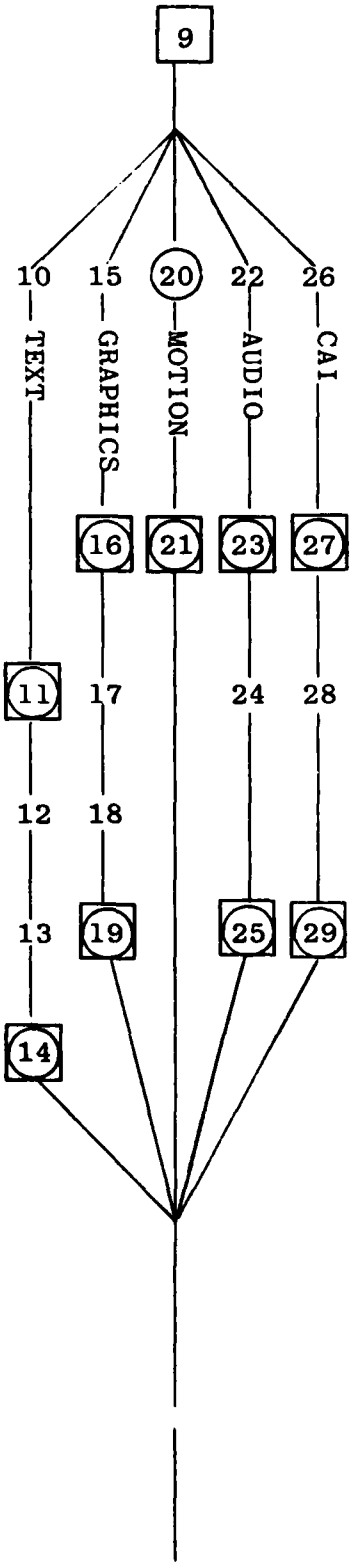
Key: SME = Subject-matter Expert
IT = Instructional Technologist

A. AUTHORING

1.	SME, IT, Director	Hold lesson specification conference and list existing materials (motion, slides, lesson plans, etc.). Review task analysis and specify lesson maps.	□ 1
2.	IT	Prepare storyboard to include (a) text, (b) graphics sketches, (c) audio, (d) specs for generative CAI, (e) source film, tape, slide or graphic material and (f) author code (SMPTE format)	□ 2
3.	SME	Review drafts	◯ 3
4.	IT	Rewrite draft materials	□ 4
5.	SME	Conduct tryouts of the paper version with individual students	◯ 5
6.	SME and IT	Revise based on tryout	◯ 6
7.	Copy preparer	Check for standard format and add specific production instructions	7
8.	Production Assistant	Obtain masters from other programs which can be incorporated into this program	8

B. MEDIA PRODUCTION

9.	Director, IT	Hold pre-production planning conference to assign text, graphics, video motion shots, narration, and CAI coding.
10.	Video Typesetter	Produce test frames on video character generator.
11.	SME and IT	Review test on video character generator
12.	Proofreader	Proof text
13.	Video Typesetter	Correct text
14.	SME and IT	Signoff text (insure that corrections were made)
15.	Artist/ photographer	Prepare rough art or photos
16.	SME and IT	Review rough art
17.	Artist/ photographer	Complete art or photos
18.	Paste-up person	Past up graphics and text if required
19.	SME, IT and Director	Signoff art
20.	Director and crew, with SME talent or consultation during shooting	Shoot new motion sequences
21.	SME, IT and Director	Signoff motion shots



22.	Narrator	Record audio tape	
23.	IT and/or SME		
24.	Audio Editor and Director	Edit narration	
25.	SME, IT and Director	Signoff on narration	
26.	Programmer	Write specs for special system functions required for disc	
27.	SME and IT	Review special functions	
28.	Programmer	Program special functions	
C.	**MEDIA TRANSFERS**		
30.	Video studio: Director	Transfer film, and if necessary, other segments to a videotape checking alignment and color balance.	30
31.	Video studio: Director and Cameraman, with IT	Transfer slides, graphics and text to a videotape special effects reel, using digital special effects if necessary	31
32.	Video technician	Make a 3/4" copy of each tape with both visual and electronic SMPTE code.	32
D.	**OFF-LINE EDIT AND REVIEW**		
33.	Editor, Director and IT	Assemble motion and still sequences and create programming list, using 3/4" copies and equipment	33
34.	IT	Review programming list and note revisions	34

E. FINAL EDITS

35.	Video studio: editor and director	Initialize videotape with SMPTE, and lay in audio track
36.	Video editor and cameraman, with IT/ writer and director	Edit the source tapes according to the edit list
37.	SME, IT and client representative	Sign off the completed tape
38.	Programmer	During disc mastering write the computer program
39.	IT/writer	Review intact program and specify changes to computer program
40.	Programmer	Revise computer program
41.	IT/Instructor	Tryout program with students and specify revisions
42.	Programmer	Revise computer program
43.	SME, IT, and client representative	Sign off the completed program.